

Technical note

Growth and performance of lambs fed a finishing diet containing either Alfalfa or Kenaf as the roughage source

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Abstract

The objective of this research was to compare Kenaf (*Hibiscus cannabinus* L.) to Alfalfa (*Medicago sativa*) as a roughage source in the finishing diets of lambs. Spring-born purebred Suffolk ewe and wether lambs (average body weight, BW = 31.8 kg) were blocked by sex and sire then randomly assigned within block to pens (total of eight pens; four pens per sex). Within sex, pens were then randomly assigned to one of two dietary treatments. Replacing Alfalfa hay in the finishing diet of lambs with Kenaf hay had no significant effect on average daily gain (Alfalfa = 200 g; Kenaf = 191 g), average daily feed consumption (Alfalfa = 1706 g; Kenaf = 1646 g), or feed efficiency (Alfalfa = 9.17 kg of feed per kg of gain; Kenaf = 9.41 kg of feed per kg of gain). From these data, we conclude that Kenaf hay can replace Alfalfa hay in the finishing diets of lambs without significantly affecting lamb performance, feed intake, or feed efficiency.

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1. Introduction

Kenaf is a tropical plant that is grown around the world as a source of fiber (USDA-ARS, 1970). Kenaf is a relatively new crop in the US with many potential commercial applications (Johnson et al., 1993; Dicks et al., 1992; Masud et al., 1990). Although mature Kenaf can be used by the fiber industry, immature Kenaf has potential as a high quality feed for livestock (Phillips et al., 1996). Throughout the growing season, Kenaf leaves contain a higher concentration of N and digestible DM than the stalk, but the proportion of leaf in the total DM decreases dramatically at about 80

days after planting (Phillips et al., 1999). To optimize forage quality and quantity, Kenaf should be harvested between 60 and 80 days after planting. Crude protein content at this time would be >15% and in situ OM disappearance could be >69% (Phillips et al., 1999; Swingle et al., 1978).

Alfalfa is used in high concentrate diets fed to lambs to provide crude protein and as a source of dietary fiber (Hunt et al., 1987; SID, 1992). Alfalfa is a perennial legume that requires a long-term investment of land and capital resources. Kenaf has been successfully used to replace Alfalfa as a crude protein supplement for lambs fed Bermudagrass or Fescue hay (Shorbert et al., 1997). As an annual crop, Kenaf affords more flexibility than perennial crops to producers that manage integrated livestock-cropping enterprises. In an integrated livestock-cropping enterprise, annual crops afford more flexibility than perennial crops and producers could market Kenaf as either a source of

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fiber or as a livestock feed. Research on the use of Kenaf as a livestock feed is limited. Therefore, the objective of this experiment was to determine feed intake, average daily gain and feed efficiency of lambs fed a high energy diet containing Kenaf as a roughage source.

2. Materials and methods

A total of 53 spring-born lambs (24 ewe lambs and 29 wether lambs) sired by three rams from the laboratory's purebred Suffolk flock were selected for the study. Average birth date of the lambs was 10 February 1997. Lambs were weaned at approximately 60 days of age, which was 6 weeks prior to the initiation of the study. After weaning, lambs had ad libitum access to a creep ration formulated to contain 75% total digestible nutrients and 14.8% crude protein.

At the beginning (28 May) and end (22 August; 86 days) of the experiment, lambs were fasted for 16 h and weighed. Lambs were sorted into two groups by sex, blocked by sire and then randomly assigned to one of four pens within each block. Pens were then randomly assigned to one of two dietary treatments. A total of eight pens (two pens per sex and diet combination) were used and each pen contained five to eight lambs of the same sex, but of different sires (Table 1). The dimensions of each pen were 5.5 m × 21.5 m and the surface of the pen was concrete. A roof covered 35% of the pen, including a self-feeder that was 2.4 m in length. Lambs had ad libitum access to the experimental diets and to water provided by a fountain in each pen.

Table 1
Distribution of lambs among the eight pens used in the experiment

Item	Ram 1		Ram 2		Ram 3		Total
	Female	Male	Female	Male	Female	Male	
1	3	–	1	–	1	–	5
2	4	–	2	–	1	–	7
3	4	–	1	–	1	–	6
4	4	–	1	–	1	–	6
5	–	3	–	3	–	1	7
6	–	4	–	2	–	2	8
7	–	3	–	2	–	2	7
8	–	3	–	2	–	2	7
Total	15	13	5	9	4	7	53

Diets were formulated to contain 11.6% crude protein and 84% total digestible nutrients to meet the crude protein and energy requirements for lambs of this body weight (BW; NRC, 1985). Ration composition was 1.3% limestone, 1.4% ammonium chloride, 5.9% molasses, 86.5% corn and 4.9% ground hay on an 'as fed' basis. Ammonium chloride was added to prevent urinary calculi and limestone was added as a buffer to reduce the incidence of rumen acidosis. Both diets also contained 33 mg/kg of an ionophore (lasalocid). Ground hay was either Alfalfa or Kenaf hay. Both forages were grown at the USDA-ARS Grazinglands Research Laboratory, harvested with conventional hay equipment, field dried, baled into large round bales, and stored in a covered structure to continue the drying process. Kenaf hay (var 'Everglades 41') was harvested at 58 days after planting during the 1996 growing season. Alfalfa was harvested in 1996 at the early- to mid-bloom stage of maturity.

Both hay sources were ground by a tub grinder to a particle length of 5 cm, then ground again by a hammer mill to a particle length of 1.2 cm before being mixed with the other ingredients of the diet. Diets were mixed in batches of approximately 908 kg at weekly intervals and delivered as needed to the self-feeders in each pen by an auger wagon. The wagon was equipped with load cells to record the amount of ration fed to each pen.

Five days after initiation of the experiment (2 June), body dimensions of each lamb was taken with a flexible tape (length and heart girth) and a rigid stand (height). Height was recorded as the distance from the top of the withers to the ground (Tatum et al., 1998). Body length was the distance along the top of the back from the point of the withers to the base of the tail-head. This method differed slightly from that used by Tatum et al. (1998). They used the point of the shoulder as the termination point, heart girth (girth) was the circumference of the chest just behind the front legs (Ensminger, 1992).

Feed intake and feed efficiency were analyzed with analysis of variance as a randomized complete block design (SAS, 1998). Pen was used as the experimental unit. The statistical model contained sex of lamb, diet, and the interaction of sex of lamb × diet. The residual sum of squares was used as the error term. Body dimension measurements and average daily gain were analyzed as a split plot design (Steel and Torrie,

1960) using the General Linear Model procedure of SAS (1998). Main plots were sex of lamb and diet. Sires were used as subplots. In this analysis, lamb was used as the experimental unit.

3. Results and discussion

The effects of diet and sex of lamb on BW, average daily gain, and body dimensions are shown in Table 2. At the beginning of the experiment, lambs assigned to receive the Alfalfa diet weighed less ($P < 0.10$) than the lambs assigned to receive the Kenaf diet. However, BW at the end of the 86-day feeding period and average daily gain were not ($P > 0.10$) different between the two dietary treatments. To account for the impact of initial BW on average daily gain, initial BW was used as a covariate in a mixed model (SAS, 1998) and was found to be a non-significant ($P > 0.10$) component in the model.

Replacing Alfalfa with Kenaf did not significantly effect average daily gain. However, there was a significant sex of lamb \times diet \times sire interaction for average daily gain. Two factors contributed to the three-way interaction. First, female lambs fed the Alfalfa diet tended to have higher average daily gain than females fed the Kenaf diet, while among the males the opposite was true. Also the lambs sired by Ram 2 had the lowest average daily gain if they were female and fed the Alfalfa diet or if they were male and fed the Kenaf diet. There is no apparent explanation for this interaction.

Feed efficiencies were similar ($P > 0.10$) between Alfalfa and Kenaf diets and female and male lambs (Table 2). Feed intake observed in this experiment was higher and average daily gain lower than reported in a previous experiment (Phillips, 1990). As a result, these lambs had poorer feed to gain conversions than previously reported. This experiment was conducted during the summer (June–August) months. Although lambs were provided shade, performance may have been reduced due to heat stress.

In this experiment, male lambs were larger ($P < 0.10$), heavier ($P < 0.05$), and consumed more ($P < 0.05$) feed than female lambs (Table 2). Although average daily gain was 15% higher in male lambs, these differences were not significant ($P > 0.10$). Tatum et al. (1998) found that ewes and wethers had similar average daily gain and required the same number of days to reach their target market weight. They also noted that wethers were taller than ewes, but similar in body length. In the present study, we also observed that wethers were taller ($P < 0.01$) than ewes (62.2 cm versus 58.9 cm) and had larger ($P < 0.05$) girths (78.8 cm versus 75.3 cm), but had similar ($P > 0.10$) body lengths (64.1 cm versus 61.0 cm). The lambs used in our study were similar in height, body length and weight to the lambs that Tatum et al. (1998) classified as small to medium frame.

Gains observed in this experiment were similar to those of previous experiments conducted at this location and in these facilities with cross-bred lambs (Hart et al., 1990; Phillips and VonTungeln, 1991; Phillips, 1993). In other studies, we looked at the

Table 2

Least square means for body weight (BW), body dimensions, average daily gain and feed intake by female and male lambs fed a finishing diet that contained Alfalfa or Kenaf hay

Item	Hay source		Lamb sex		S.E. ^a
	Alfalfa	Kenaf	Female	Male	
Initial BW (kg)	30.1 ^b	33.4 ^c	29.7 ^d	33.8 ^e	1.3
Final BW (kg)	46.1	48.5	43.6 ^f	50.9 ^g	1.7
Average daily gain (g)	186	175	162	199	26
Height (cm)	59.6 ^b	61.4 ^c	58.9 ^f	62.2 ^g	0.7
Length (cm)	61.5	63.6	61.0	64.1	1.0
Girth (cm)	75.5 ^b	78.5 ^c	75.3 ^d	78.8 ^e	1.1
Feed intake (g per day)	1706	1646	1502 ^d	1850 ^e	85
Feed efficiency (intake/gain)	9.17	9.41	9.27	9.30	1.1

Means in the same row and category with different letters differ (b, c: $P < 0.10$; d, e: $P < 0.05$; f, g: $P < 0.01$).

^a Standard error.

relationship between initial BW and average daily gain during the finishing phase (Phillips, 1990; Phillips and VonTungeln, 1991). In those studies, lambs were classified on initial BW as light (BW = 28 kg), medium (BW = 31 kg) or heavy (BW = 36 kg). As initial BW increased, so did average daily gain and daily feed intake. As a result, lambs in the heavy class were fed for shorter periods of time and were more efficient than lambs in the light class. Tatum et al. (1998) used frame size to classify lambs purchased from 10 different points of origin and related frame size to average daily gain. They concluded that large frame lambs gained weight more rapidly than small frame because they matured at a slower rate, which delayed the time at which they shifted from depositing lean tissue to depositing fat. At a constant BW of 56 kg, large frame lambs had less fat thickness, body wall thickness, and lower yield grades. Our earlier studies support these observations, even though we used initial BW as a classifier. By classifying lambs based on initial BW, we were inadvertently classifying them based on frame size.

Body dimensions (length and girth) have been used to estimate BW. Ensminger (1992) proposed a formulae of (girth \times girth \times length) divided by 10,824 to estimate BW in kg. Applying his formulae to the body dimensions observed in this experiment overestimated BW by about 2 kg. This difference could be due to the method we used to estimate body length.

Lambs sired by the three rams used in this experiment were similar in height (60.5 cm), but varied in body length (Ram 1 = 63.9 cm; Ram 2 = 61.1 cm; Ram 3 = 62.6 cm). Lambs sired by Ram 2 had shorter body length and lower average daily gain (169 g) than lambs sired by Ram 1 (199 g) or Ram 3 (172 g). To explore this relationship of height and body length to average daily gain, we calculated a height to body length ratio for each lamb and regressed it against average daily gain. There was no significant relationship between this ratio and average daily gain.

From these data, we conclude that Kenaf hay can replace Alfalfa hay in the finishing diets of lambs without affecting lamb performance or feed intake. Reports from this location as well as from other researchers indicate that Kenaf protein is very soluble (Suriyajantraton et al., 1973; Phillips et al., 1999). Protein found in Kenaf contains a high proportion of ruminally degradable protein, which can affect rumen

microbial growth, DM intake, and microbial protein synthesis (Hunt et al., 1987; Westerndorf and Gordon, 1998). Further investigation into the degradability of Kenaf protein is warranted before the use of Kenaf as a forage source in high concentrate diets for lambs can be fully exploited. Although sire had no effect on lamb performance, average daily gain was positively correlated with lamb height and body length, especially in female lambs.

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